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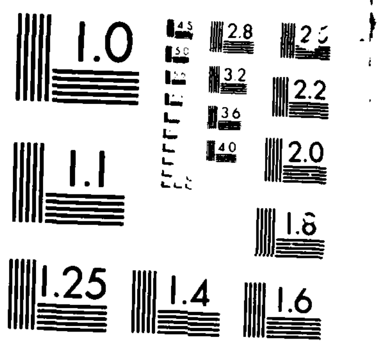
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AFGL-TR-86-0001

FABRICATE, CALIBRATE and TEST A DOSIMETER FOR INTEGRATION INTO THE CRRES SATELLITE

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(For the period 1 September 1984 - 31 August 1985)

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AIR FORCE GEOPHYSICS LABORATORY
AIR FORCE SYSTEMS COMMAND
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"This technical report has been reviewed and is approved for publication"

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FOR THE COMMANDER

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A space-radiation dosimeter is being fabricated, calibrated, tested, and integrated into the CRRES satellite. This Dosimeter is essentially identical to that previously designed, fabricated, calibrated, tested and integrated into the DMSP F7 satellite. These dosimeters are primarily designed to measure the dose from electrons of greater than 1 MeV to greater than 10 MeV in four channels. Each channel has a different thickness aluminum dome. The solid state detector outputs are processed

20. Abstract (Continued)

to provide the dose from electrons (low energy loss), the dose from protons (high energy loss), the flux of electrons, the flux of protons, and the rate of high energy loss nuclear star events. The dosimeter also has a calibration mode in which the alpha particles from a weak source behind each detector are used to check for total detector depletion and proper operation of the electronics.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

LIST OF TABLES

1. INTRODUCTION

The increasing use of complex solid state electronic devices in the space radiation environment makes it important to have reliable data on the radiation doses these devices will receive behind various thicknesses of shielding. As part of the effort to obtain this data a Dosimeter was designed, fabricated, calibrated, and integrated into the payload of a Defense Meteorological Satellite Program (DMSP) satellite by Panametrics, Inc., for the Air Force Geophysics Laboratory, under contract number F19628-78-C-0247. The current contract, F19628-82-C-0090, is for the fabrication and calibration of a second, essentially identical, Dosimeter and its integration into the Combined Release and Radiation Effects Satellite (CRRES). These Dosimeters measure the accumulated radiation dose in silicon solid state detectors behind four different thicknesses of aluminum shielding. The current contract also covers the integration into the CRRES spacecraft and launch support of the Fluxmeter, a high energy electron spectrometer being built by Panametrics for AFGL under contract number F19628-79-C-0[illegible]75.

The objectives of the current contract can be summarized as follows:

a. Participate in the integration and launch tests of the F7/DMSP satellite in order to determine proper interfacing, of the Dosimeter, with other satellite components and proper operation prior to, and immediately after launch.

b. Study the DMSP Dosimeter calibration and early flight data to determine the optimum method of producing omnidirectional spectra from the electron and proton data and determine the dose calibrations for small, large and very large energy deposition levels.

c. Fabricate, test, calibrate and deliver a radiation Dosimeter, essentially identical to the DMSP Dosimeter, for integration into the CRRES satellite.

d. Participate in the integration and launch tests of the CRRES satellite in order to determine proper interfacing, of the Dosimeter and Fluxmeter, with other satellite components and proper operation prior to, and immediately after launch.

e. Analyze calibration and early flight data of the CRRES Dosimeter to determine the performance of the Dosimeter in space flight and the quality of flight data.

The work carried out during the first (1 September 1982 to 31 August 1983) and second (1 September 1983 to 31 August 1984) years of this contract have been reported in Refs. 1.1 and 1.2, respectively. This report covers the work carried out during the

third year (1 September 1984 to 31 August 1985). A brief description of the Dosimeters, and a summary of their specifications, are given in Section 2. Section 2.1 deals specifically with the DMSP Dosimeter while Section 2.2 deals with the CRRES Dosimeter. The progress to date is summarized in Section 3. Section 3.1 covers the DMSP integration and launch support (item a, above) while Section 3.2 covers the DMSP calibration and flight data analysis (item b). Section 3.3 covers the CRRES Dosimeter fabrication, testing and calibration (item c) and Section 3.4 covers the CRRES Dosimeter and Fluxmeter integration and launch support (item d). No effort has yet been expended on item e, since it cannot begin until item d is completed.

2. DOSIMETER DESCRIPTIONS AND SPECIFICATIONS

2.1 Description and Specifications of the DMSP Dosimeter

The DMSP Dosimeter was designed, fabricated, tested and calibrated by Panametrics, Inc., for the Air Force Geophysics Laboratory, under contract number F19628-78-C-0247. This instrument's specifications are outlined in Table 2.1. It should be noted that the unit was specifically designed to interface with the DMSP spacecraft and its Operational Linescan System (OLS). The DC to DC converter design, in particular, took advantage of the closely regulated DMSP power buss (28.0 $\pm$ 0.5 VDC) which eliminates the requirement for further line voltage regulation and results in reduced power consumption, weight and volume. The data registers are also optimally scaled for the approximate circular 800 km DMSP orbit. A detailed description of the DMSP Dosimeter is presented in Ref. 2.1. The design is, of course, adaptable to other spacecraft and/or orbits.

An isometric view of the DMSP Dosimeter is shown in Fig. 2.1. The 4 domes house the solid state detectors. The dome thickness increases with the size, resulting in four different incident particle energy thresholds. The instrument interfaces to the DMSP spacecraft through P1 and to the OLS through P2. J12 is a test connector which is capped during flight. A cutaway isometric view, showing the various printed circuit boards and the details of one detector, is given in Fig. 2.2. The four charge sensitive preamplifier test input connectors, shown in Fig. 2.2, are also capped for flight.

The Dosimeter separates the total radiation dose into that from electrons (50 keV to 1 MeV energy deposits) and protons (1 to 10 MeV energy deposits). The four aluminum shields provide energy thresholds (range thickness values) of 1, 2.5, 5, and 10 MeV for electrons, and 20, 35, 51, and 75 MeV for protons. The primary measurement, and that most accurately calibrated, is the accumulated dose. Omnidirectional electron and proton fluxes are also measured, and data on the detailed response of each channel to energy and angle for electrons and protons

Table 2.1

Specifications for the DMSP Dosimeter

Sensors	4 Planar silicon S.S.D. with aluminum shields
Field of View	2π Steradians
Data Fields	3 deposited energy ranges and 2 dose energy ranges per sensor, resulting in 5 data fields: 1 Electron Dose 1 Electron Flux 1 Proton Dose 1 Proton Flux 1 Nuclear Star Flux
Output Format	36 Bits serial, read out once per second. Each readout is internally multiplexed and must be interpreted in the context of a 64 readout data frame.
Command Requirements	On/Off, Reset, and Calibrate
Size	8" H x 4.5" W x 5.5" D excluding Domes, Connectors, and Mounting Tabs
Weight	10 lbs
Power	7 W @ 28 V $\pm$ 0.5 V DC
Temperature Range	-10^{o}C to 40^{o}C
Max Accumulated Dose before recycling	$\simeq 10^4$ rads (Si) Electrons $\simeq 10^3$ rads (Si) Protons
Max Flux before overflow	$\simeq 10^6$ Electrons/(cm^2-sec) above 1 Mev $\simeq 10^4$ Protons/(cm^2-sec) above 20 MeV
Effective Area (For omnidirectional flux)	0.013 cm^2 (Dome 1), 0.25 cm^2 (Dome 2, 3, and 4)

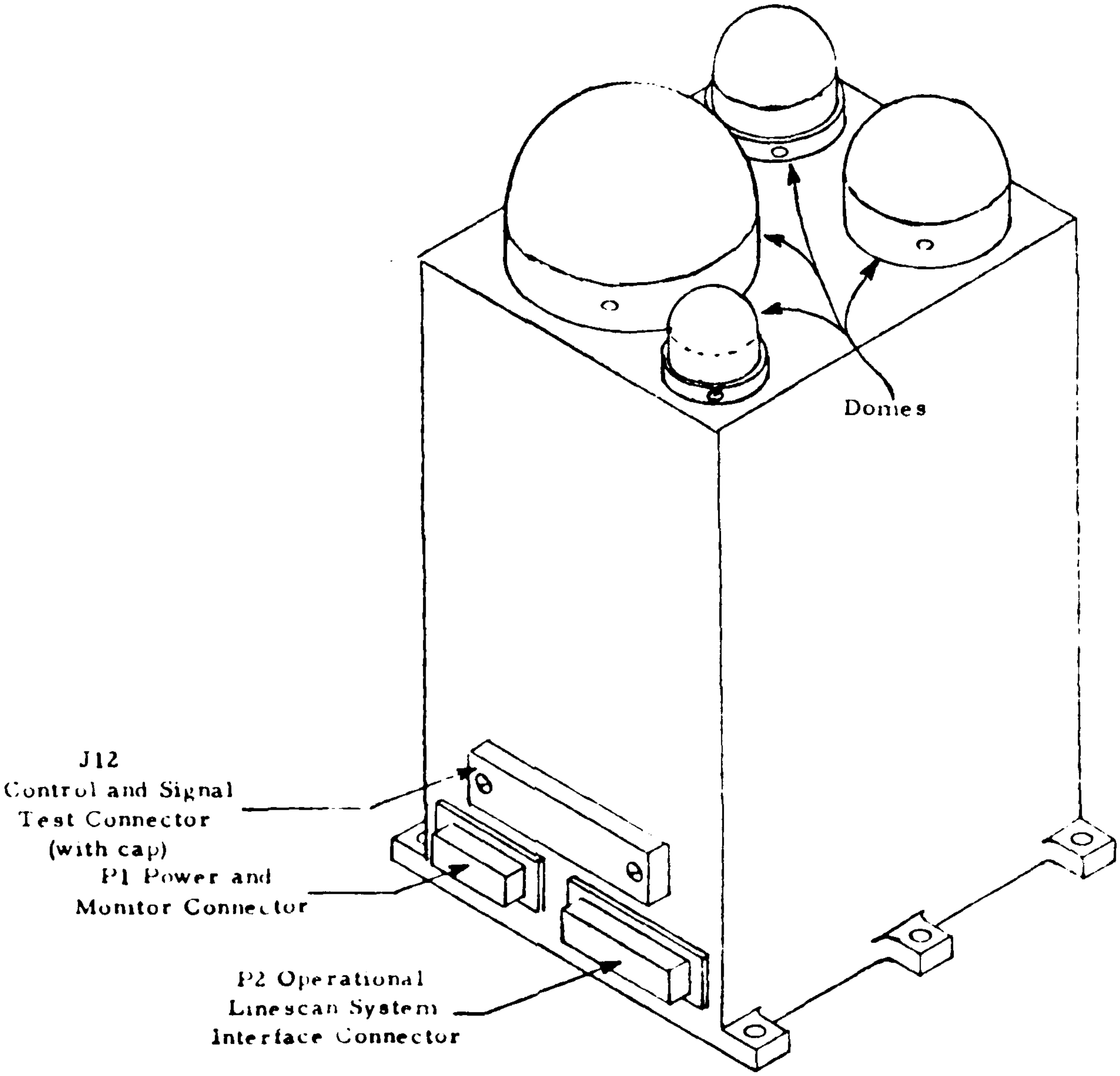

Fig. 2.1 Isometric View of the DMSP Dosimeter

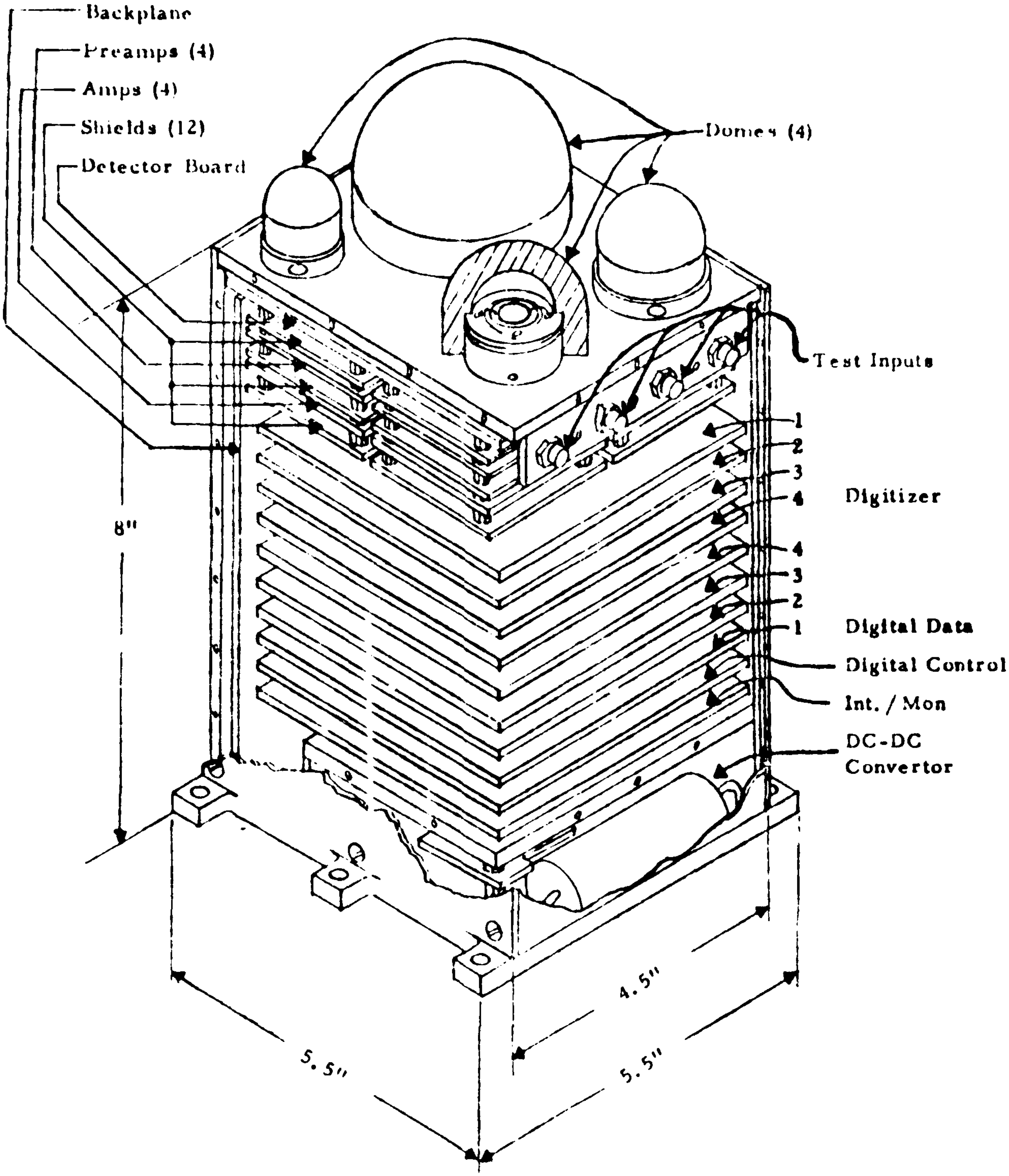

Fig. 2.2 Cutaway Isometric View of the DMSP Dosimeter

have been obtained. There is also a high energy loss event channel which counts the rare nuclear star events caused by high energy protons, and the low flux of high energy, high-Z cosmic rays. Information on these high energy loss events is important, since they can cause logic upsets or memory bit loss in some types of low power micro-circuits.

The DMSP Dosimeter was extensively calibrated by use of protons from the Harvard Cyclotron, and electrons from the AFGL Linac. The 160 MeV proton beam at the Harvard cyclotron was passed through two beam-spreading absorbers to provide a maximum energy of 144 MeV at the Dosimeter. Additional absorbers were used to reduce the energy to as low as 17 MeV. Data were taken for incident directions (relative to the dome plane normal) of from 0° to 180° (rear entry). The electron data taken at the AFGL linac covered the range of 0.9 to 13.4 MeV. The nominal electron energies were calibrated against known gamma-ray energies with a 1 inch thick BGO crystal, so the corrected energies should be accurate to better than 5%. The Dosimeter was also calibrated extensively using gamma ray and beta sources, with this being the primary method of calibrating the dose channel responses. The electron and proton beam calibrations are primarily to verify proper unit operation, and to calibrate the flux channels in terms of the incident particle fluxes.

The final parameters for the four channels of the DMSP Dosimeter are given in Table 2.2. These values are based on the final dose prescaler values and the calibrated detector responses. The electron channels are based on detector energy losses of 50 keV to 1 MeV, and the proton channels on 1 MeV to 10 MeV. In the calibration mode the electron channel becomes a lower loss range of 1 to 3 MeV and the proton channel an upper loss range of 3 to 10 MeV. This mode is used to check total depletion of the detectors by looking at the alpha source which irradiates the rear of the detectors.

The DMSP Dosimeter underwent a complete acceptance test sequence, in accord with a Test and Acceptance Plan approved by AFGL. Vibration testing was carried out at the AFGL test facility. Thermal and vacuum testing were done in house at Panametrics. Initial spacecraft integration tests took place at the Westinghouse facility in Baltimore, Maryland (the OLS contractor) and the Dosimeter was shipped to RCA Astroelectronics Division (the spacecraft contractor) on June 2, 1981 for integration into the DMSP F-7 spacecraft.

2.2 Description and Specifications of the CRRES Dosimeter

The specifications for the CRRES Dosimeter which is being fabricated, tested and calibrated by Panametrics, Inc. for the Air Force Geophysics Laboratory, are outlined in Table 2.3.

Table 2.2

Final Parameters for the DMSP Dosimeter

Item	Ch 1 Value	Ch 2 Value	Ch 3 Value	Ch 4 Value
Al Shield (g/cm^2)	0.55	1.55	3.05	5.91
Electron Threshold (MeV)#	1.0	2.5	5.0	10.
Proton Threshold (MeV)#	20	35	51	75
Star Threshold (MeV)#	40	40	75	40
Detector Area (cm^2)	0.051	1.00	1.00	1.00
Max elect. flux (cm^{-2} sec^{-1})*	2.41×10^6	1.23×10^5	1.23×10^5	1.23×10^5
Max proton flux (cm^{-2} sec^{-1})*	1.95×10^4	922	922	922
Elect. dose prescaler	8192	16384	4096	4096
Proton dose prescaler	64	1024	256	256
Max. elect. dose (RADS)**	1.27×10^4	1.29×10^3	323	323
Max. proton dose (RADS)**	990	808	202	202
Electron calibration constant (RADS/output dose count)	1.78×10^{-3}	1.81×10^{-4}	4.30×10^{-5}	4.85×10^{-5}
Proton calibration constant (RADS/output dose count)	1.36×10^{-4}	1.11×10^{-4}	2.90×10^{-5}	2.92×10^{-5}

*Flux value above which the flux count will overflow. Only the flux readouts are affected, as dose is still accumulated correctly.

**Dose at which the counters overflow and recycle to zero. Dose accumulation continues correctly.

#The electron and proton thresholds are the nominal particle energy to just penetrate the dome shields; the star thresholds refer to energy deposits in the detectors.

Table 2.3

Specifications for the CRRES Dosimeter

Sensors	4 Planar silicon S.S.D. with aluminum shields
Field of View	2π Steradians
Data Fields	3 deposited energy ranges and 2 dose energy ranges per sensor, resulting in 5 data fields: 1 Electron Dose 1 Electron Flux 1 Proton Dose 1 Proton Flux 1 Nuclear Star Flux
Output Format	36 Bits serial, read out once per second. Each readout is internally multiplexed and must be interpreted in the context of a 64 readout data frame. (The CRRES spacecraft actually reads 40 bits - the 36 data bits followed by 4 logical zeroes).
Command Requirements	On/Off, Reset, and Calibrate
Size	8" H x 4.5" W x 5.5" D excluding Domes, Connectors, and Mounting Tabs
Weight	10.6 lbs
Power	7.5 W @ 28 V $\pm$ 4.0 V DC
Temperature Range	$-10^{o}C$ to $40^{o}C$
Max Accumulated Dose before recycling	$\simeq 10^4$ rads (Si) Electrons $\simeq 10^3$ rads (Si) Protons
Max Flux before overflow	$\simeq 10^6$ Electrons/(cm^2-sec) above 1 MeV $\simeq 10^4$ Protons/(cm^2-sec) above 20 MeV
Effective Area (For omnidirectional flux)	0.013 cm^2 (Dome 1), 0.25 cm^2 (Dome 2, 3, and 4)

These specifications are iden ical to those of the DMSP Dosimeter except for the following two tems:

a) The CRRES power b ss regulation is 28.0 ± 4 VDC, as opposed to the 28.0 ± 0.5 VDC DMSP power buss. This necessitates the addition of a line voltage regulator, and it results in a slight increase in the instrument's weight and power requirements - which are reflected in Table 2.3.

b) The peak high energy proton flux at the specified CRRES orbit is about a factor of 10 higher than that at the DMSP orbit. This necessitates the addition of prescalers in the three highest energy proton flux channels to prevent counter overflow. This modification has no impact on the instrument's volume, negligible impact on power requirement and a very slight impact on its weight.

The mechanical configuration of the CRRES Dosimeter is identical to that of the DMSP Dosimeter, as shown in Figures 2.1 and 2.2.

3. PROGRESS TO DATE

3.1 DMSP Dosimeter Integration and Launch Support

It should be noted that the DMSP instruments are referred to as "special sensors" and that the Dosimeter is designated the "SSJ*" special sensor.

Integration and testing of the DMSP F-7 spacecraft was completed in November 1983 and the spacecraft was launched, with the SSJ* Dosimeter on board, late that month. The SSJ* Dosimeter was first turned on in Rev 77 on 23 November 1983 at 1615 UT. At turn-on the temperature was +11°C, which decreased to +6°C during the first orbit cycle, but climbed to +46°C at the start of Rev 84. The Dosimeter was thus turned off at 0430 UT on 24 November 1983. The Dosimeter was turned on again at 0850 UT on 25 November 1983, in Rev 101. The temperature started at +17°C and increased over the next several orbits, reaching a plateau of 50°C ± 3°C by Rev 121 (1830 UT on 26 November), with the ± 3°C being the sun/shadow cycling for each orbit. The temperature variations for Revs 77 to 85 are shown in Fig. 3.1, for Revs 101 to 111 in Fig. 3.2, and for Revs 11 to 121 in Fig. 3.3.

Analysis of Normal Mode and Calibration Mode data indicated completely proper operation of the Dosimeter, both at the low temperature after turn-on, and at the maximum temperature of 53°C. The Am^{241} calibration source data during periods of low ambient background indicated the detectors were still totally depleted. Thus the dose and flux data were all valid using the pre-launch calibrations.

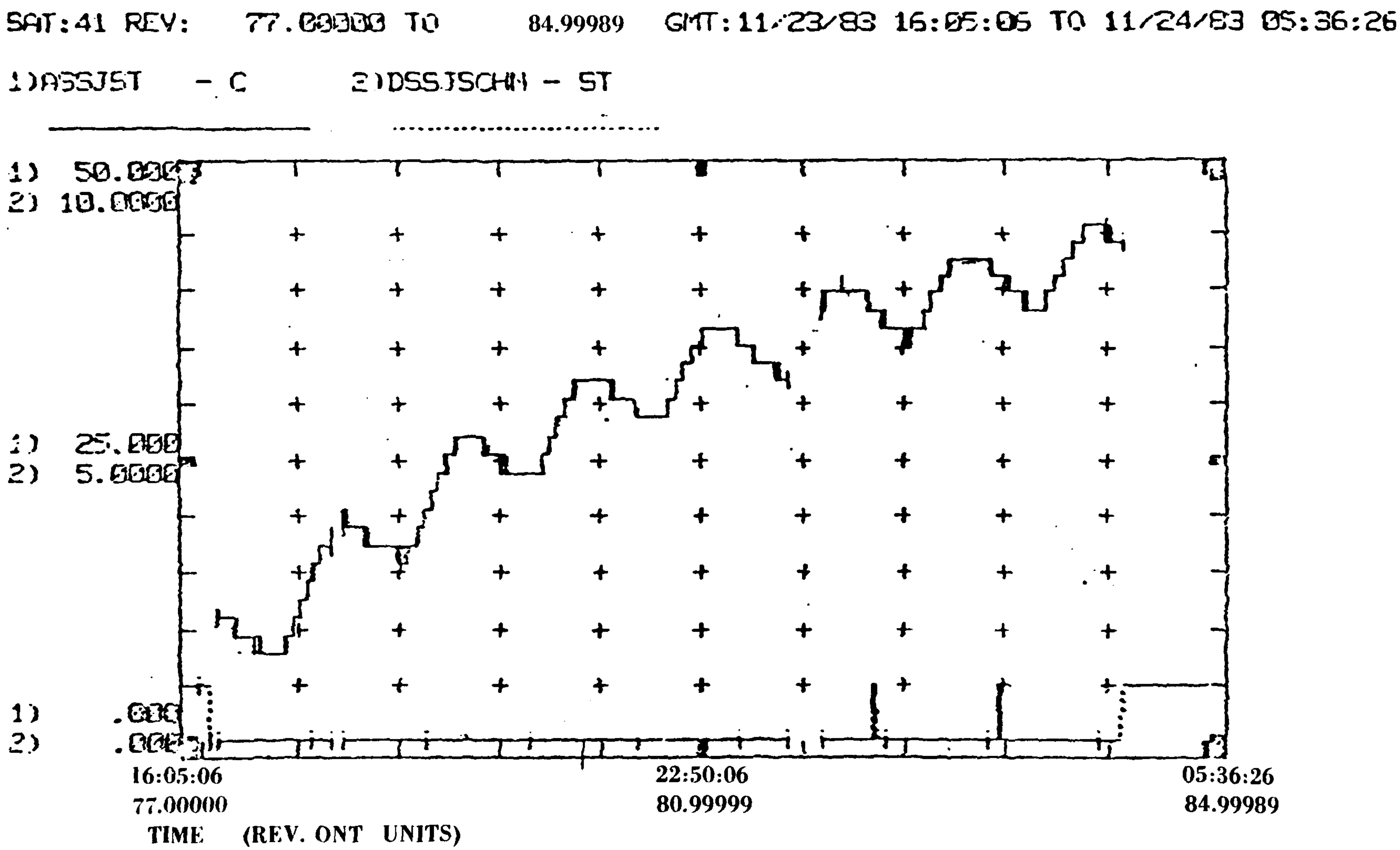

Figure 3.1 SSJ* Dosimeter Temperature Variations After First Dosimeter Turn-On.

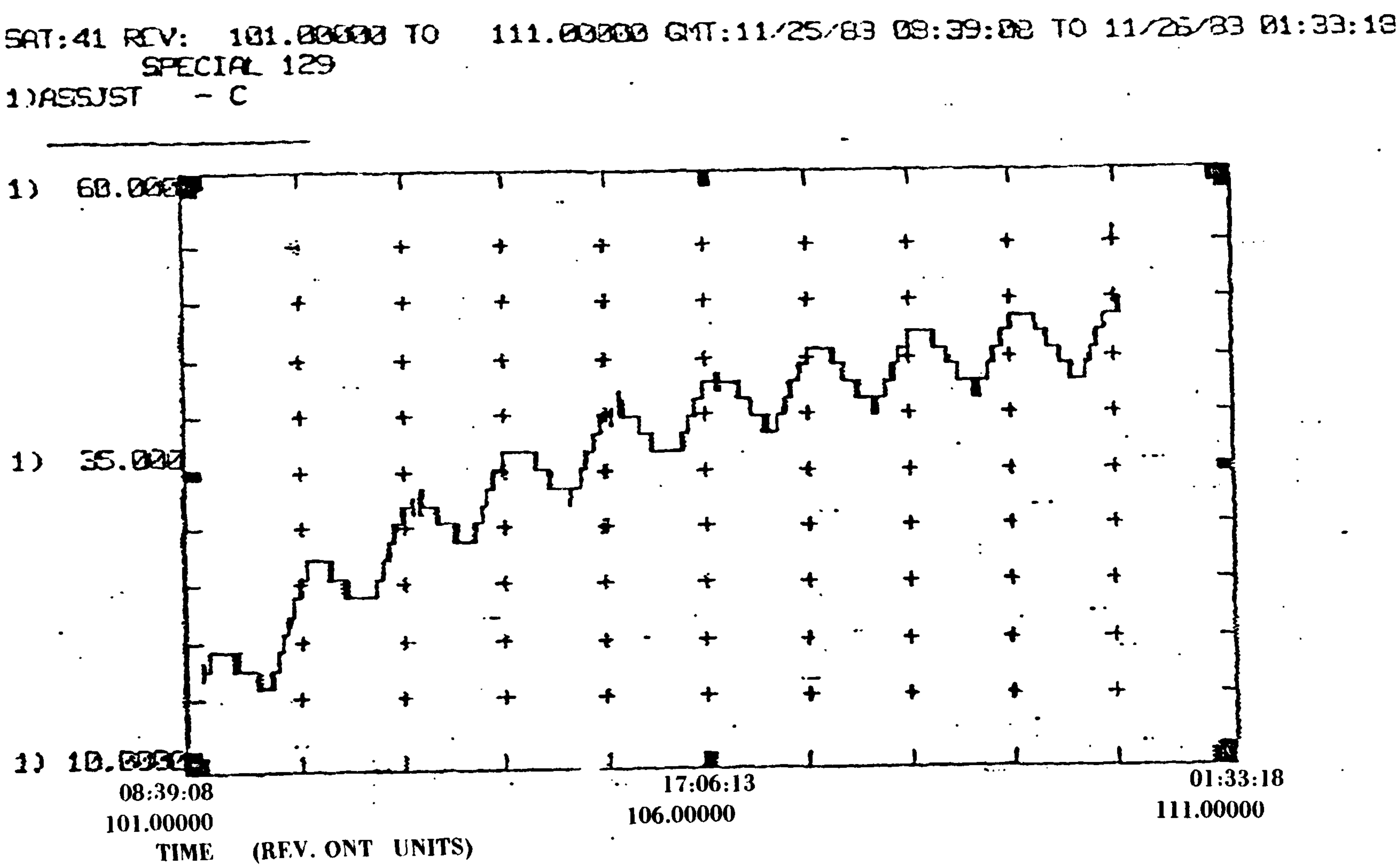

Figure 3.2 SSJ* Dosimeter Temperature Variations after Second Turn-On.

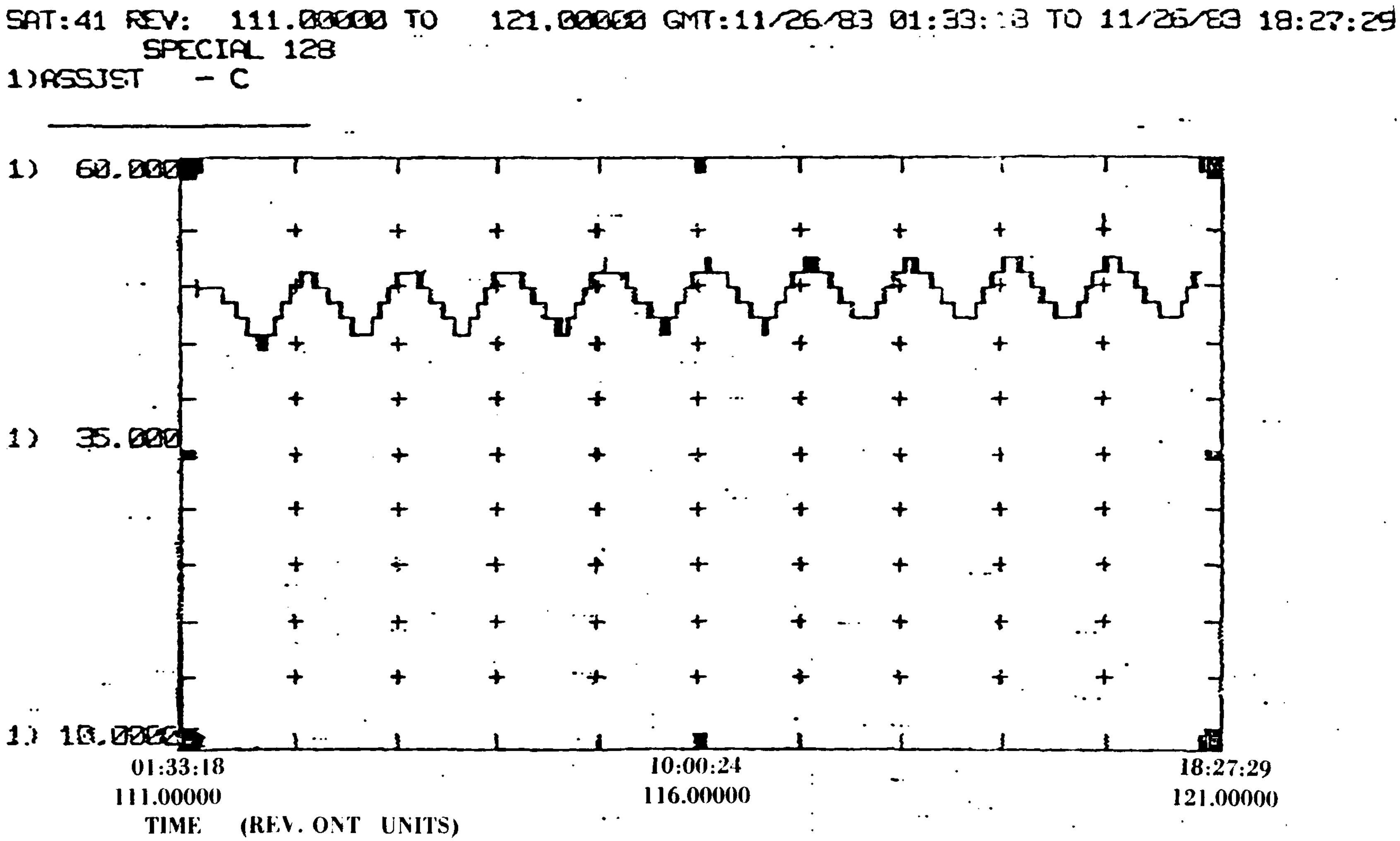

Figure 3.3 SSJ* Dosimeter Temperature Variations as Equilibrium is Achieved.

The predicted in-orbit temperature for the Dosimeter was +26°C for the minimum 30° solar zenith angle of the DMSP-F7 orbit. The originally specified operating temperature range for the SSJ* was -10°C to +40°C, so the actual operating temperature exceeds this by +13°C. Since the SSJ* Dosimeter was operating properly, the operating specifications given to GWC (Global Weather Central) were changed to: 1) notify AFGL/Panametrics if the temperature exceeds +55°C; and 2) turn the SSJ* off if the temperature exceeds +60°C.

Dosimeter temperature data obtained for 15 February 1984 show a temperature cycle of 45.8°C to 51.4°C, slightly lower than at the end of November 1983. The DMSP Dosimeter temperature peaked during November-December 1984, reaching a maximum of 55.2°C. A plot of five (5) orbits of temperature data for 2 December 1984 is shown in Fig. 3.4. By late February 1985 the maximum temperature had decreased to 52.9°C.

In mid-November 1984, a number of phone calls were received from Ben Pope of Westinghouse about the temperature rise and its expected peaking in November. A number of Cal Mode print-outs from the AWS were requested and have been analyzed. On Friday, 23 November 1984, F. Hanser of Panametrics was notified by the AWS that the Dosimeter had reached 55.2°C, past the notification level of 55°C. Dosimeter operation was continued, with shut-off remaining at 60°C. Additional Cal Mode data and two full orbits of regular mode data were obtained from Ben Pope. Analysis of these data show that the D4 electron channel reaches a peak noise count-rate of about 500/sec at the maximum temperature of about ~55°C, and falls to the background level of about 10/sec at 48.5°C. The Cal Mode data show that even at the peak temperature of 55°C all the detectors are fully depleted and all gains and thresholds are correct. The Dosimeter is thus operating properly at 55°C after one year in orbit at about a 50°C average temperature, with only D4 showing an increase in noise at 55°C. This was discussed with AFGL personnel and it was recommended that the Dosimeter be left on continuously, since on/off cycling to lower the temperature was likely to be more stressful.

The background count-rate in the D4 electron channel is not excessive and does not produce a significant dead time (less than 0.1%). The D4 electron dose will have to be corrected for the noise addition. None of the other channels has a significant contribution from noise. This indicates that the Dosimeter should operate reliably for at least one more year, with the D4 electron channel noise probably being higher in November 1985, at the next temperature maximum, although it is still likely to provide usable data. The Dosimeter operation in orbit is excellent considering that it is operating at 10 to 15°C above the specification maximum of 40°C.

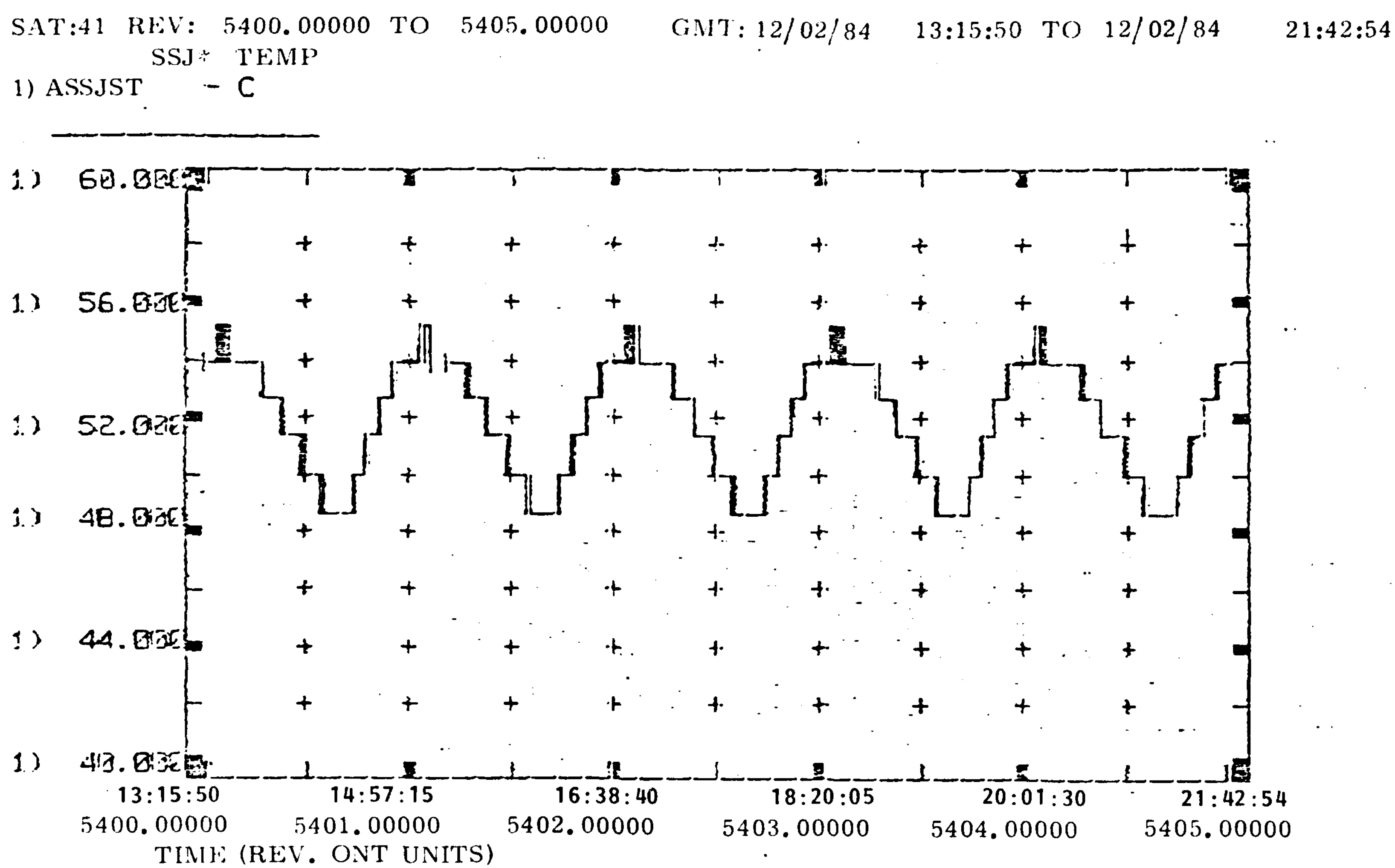

Figure 3.4 SSJ* Dosimeter Temperature Variations During Maximum of November - December 1984.

A VAR (Vehicle Anomaly Report) was opened by GWC to, at least, document, and possibly, determine the cause of the SSJ* temperature problem. The SSJ* is mounted to the DMSP satellite with electrical isolation at the base, and a thermal insulating blanket around the sides. Most of the heat radiation thus takes place through a teflon tape on the top surface around the detector domes. The high temperature could thus be the result of contamination of the tape surface reducing its emissivity, or of the tape partially pulling away from the surface. During the various integration, thermal vacuum, etc., tests at RCA, the Dosimeter temperature never exceeded +30°C, although this is only for about 4 hours of operation. The VAR was closed in August 1984, with the conclusion that it is most likely a thermal design error. The Dosimeter power consumption was verified to be 6 W, as specified, while the base plane temperature is about 10°C. The thermal design assumed a thermal conductivity between the Dosimeter and the base plane of 0.22 W/°C, which is apparently too high as this would put the Dosimeter at about 37°C (which is close to the +40°C maximum specifications for the Dosimeter!). Since the Dosimeter is electrically isolated from the spacecraft at its mounting points, this probably contributed to the problem of lower thermal conductivity to the spacecraft.

A check of test records at Panametrics shows that in May 1982, when the Dosimeter was returned to Panametrics for a grounding modification and check-out, the Dosimeter was given a two-week test in vacuum where it ran at about 50°C. These test data show proper Dosimeter operation at that temperature, so the in-orbit 50°C ± 3°C operation has actually been tested before launch (for a relatively short-term period). The Dosimeter electronics have been tested to much higher temperatures, so the detectors are the only potential problem at high temperature. The detectors are photodiodes operated as particle detectors at total depletion. At high temperatures the leakage current increases, leading to eventual partial depletion, and the noise level increases, leading to excessive noise in the electron channels. At +50°C the detectors are still totally depleted, and noise is still not noticeable at the 50 keV electron threshold.

3.2 DMSP Dosimeter Flight Data Analysis

The routine analysis of the DMSP F7 Dosimeter flight data at AFGL is basically in operation. The algorithim for obtaining the dose and flux increments from the DMSP Dosimeter data were completed and have been verified with checks against actual data. The final procedure corrects the four-second dose increments for ripple counter overflow. A check against South Atlantic Anomaly data shows that the summed dose increments equal the actual dose increment between dose mantissa changes to within the beginning and ending ripple count increments, which is the maximum possible accuracy within the readout resolution. A procedure has also been developed to correct the data for dead-time

effects. This is a simple calculation which can be easily added when necessary. A check of the SAA and maximum polar cap solar particle data shows that the maximum dead-time effect observed thus far is 5%.

All channels are operating properly, although there is some noise added to the dome 4 electron channel (> 10 MeV electrons) count at the higher temperatures on each orbit. The dome 4 detector starts showing noise counts at temperatures above 50°C, while the other 3 detectors show no noise at 55 to 56°C, the maximum observed temperature. The dome 4 electron flux and dose channels may need correction for this temperature-caused background during periods of low ambient fluxes.

A minor problem is showing up in the routine checking for total dose increments. These routines do not check for valid data and seem to be tripped by noise. A detailed check of the false total dose changes shows that the problem is the occurrence of zeroes in the normal SSJ* data stream, and that the Dosimeter is functioning properly. Some months ago Ben Pope notified Fred Rich of AFGL and Fred Hanser at Panametrics that there had been a minor programming error with the DMSP satellite that resulted in the addition of some zeroes to the SSJ* data stream. The problem occurred with decom at Global Site 3, where the data was stripped out from the telemetry stream. Some of the equipment at site 3 was inadequate and threw out some of the data, leaving zeroes for later processing. This problem occurred from the beginning (November 1983) and was not completely diagnosed until 12 July 1984. The solution required some new equipment for the processing and was corrected by 24 August 1984. It is not certain how extensive the problem was with the earlier data. The processing errors were not consistent and were not noticed until July 1984, when they appeared to be getting worse. The observed zeroes affect only a small amount of data, but require additional checks for total dose increments to avoid generating false increment print-outs.

Some of the Dosimeter data at AFGL have been reduced to flux contour plots over magnetic latitude/longitude coordinates. The proton fluxes show primarily the South Atlantic Anomaly (SAA), while the electron fluxes show the SAA and the north/south low altitude edges of the radiation belts. The Star fluxes show the SAA (from high energy proton reactions) as well as the polar caps (from cosmic rays - proton interactions as well as heavier particles).

3.3 CRRES Dosimeter Fabrication, Calibration and Testing

Fabrication of the CRRES Dosimeter is essentially complete - except for mounting and installation of the solid state detectors.

The CRRES Dosimeter is identical to the DSMP Dosimeter except that the DC to DC converter design has been modified and proton flux prescalers have been added.

The CRRES Dosimeter must operate from a 28 ± 4 volt buss, rather than the 28 ± 0.5 volt buss which the DMSP spacecraft provides. The tightly regulated DMSP buss was taken advantage of in the design of the Dosimeter, by not including any line voltage regulation in the instrument. This resulted in a significant power savings (~1/2 watt) but prohibited operation with CRRES's unregulated buss. It was originally proposed that a buss voltage regulator be placed inside a 1" x 4" x 4" housing to be attached to the side of the Dosimeter and the design proceeded in that direction. However, as the design of the preregulator evolved, it became apparent that incorporating line voltage regulation into a totally new DC to DC converter design would be far better and that is the approach which has been implemented. Thus, the CRRES Dosimeter contains a newly designed DC to DC converter, with line voltage regulation, which occupies the same volume as the original DMSP Dosimeter's DC to DC converter - the 1" x 4" x 4" added volume is not required.

The proton fluxes in channels 2, 3 and 4 of the DMSP Dosimeter are all within a factor of 2 of overflow at 4096 counts. The maximum SAA L-shell for DMSP is about 1.2 while the maximum trapped flux occurs at L = 1.4 - 1.5 and is about a factor of 5 larger. The CRRES Dosimeter would thus have proton flux counter overflows for these three channels unless some prescaling is done. This situation was investigated and it was determined that prescalers could be implemented within the contract scope. Thus, the CRRES Dosimeter contains proton flux prescalers in channels 2, 3, and 4. Prescale factors of 1, 2, 4, 8 or 16 are individually selectable (by jumpers) for each channel. The prescalers are not reset, so no counts are lost at low flux levels.

In August, 1985, a number of meetings were held at AFGL to discuss the desired detector configuration of the CRRES Dosimeter. Using current models of the Radiation Belt electron and proton fluxes, the D2, D3 and D4 proton channels would have dead-time corrections of 10-20% at L ~ 1.5, while the D1 and D2 electron channels would have dead time corrections of 75-125% at L ~ 4-4.5. These corrections are readily made in ground processing, and pulse pile-up is not a significant factor since the dead-time results primarily from the data processing time. However, the in-orbit total dose read-outs would have to be corrected for these dead-time effects, and this makes the total dose read-outs more difficult for other CRRES experimenters to use. The dead-time corrections can be significantly reduced by using a 0.008cm^2 detector for D1, and 0.051cm^2 detectors for D2 and D3. This change would eliminate the proton flux prescaler requirements for D2 and D3 and reduce dead-time correction to less than 10% at the peak flux regions. The AFGL discussions resulted in a recommend-

ation for the detector-size modification in the CRRES Dosimeter. AFGL personnel will initiate a change request for the Contract, to implement these recommendations.

3.4 CRRES Integration Support

3.4.1 Interface Control Document (ICD)

Revision C of the ICD was reviewed by AFGL, BASD and Panametrics personnel at AFGL on 10 October 1984. Several minor modifications were noted at that time. These have apparently been incorporated and it is our understanding that the ICD was signed by AFGL in late October or early November - Panametrics has not yet received a copy of the signed ICD.

3.4.2 Experimenters Working Group Meeting

The twelfth experimenters working group meeting was held at AFGL on 9-10 October 1984 and was attended by Panametrics' J. Hunerwadel and P. Morel. The first day was devoted to various presentations by BASD personnel while the second day was devoted exclusively to reviewing the ICD's.

3.4.3 AFSCF Support

Preliminary mode display requirements for the Dosimeter and Fluxmeter were conveyed to AFGL's D. Hardy on 13 September 1984. These were incorporated into an AFGL document which defines the mode display requirements for all AFGL CRRES Particle Experiments. Said document was forwarded to Lockhead Missile & Space Company's Dale Peterson on 27 September 1984, with a copy to Panametrics.

3.4.4 Mass Simulators

A 27 August 1984 letter from AFGL's Captain Riehl requested that Panametrics provide mechanical drawings by 1 October 1984, which are detailed enough to allow construction of mass simulators per paragraph 5.2.3. of the ICD. A complete set of our machined part fabrication drawings were forwarded to AFGL on 28 September 1984.

3.4.5 Mechanical Interface Control Drawings

Updated Dosimeter and Fluxmeter mechanical interface control drawings were forwarded to BASD's Carl Holmes on 22 January 1985. The updated drawings incorporated the larger Fluxmeter mounting holes and Dosimeter flange doublers, as requested by BASD. Copies of these drawings were also forwarded to R. Vancour on 22 January 1985.

3.4.6 R & D Test and Acceptance Plan

The R & D Test and Acceptance Plan was submitted on 19 April 1985. Approval of this plan was received on 24 April 1985.

3.4.7 Turn-On, Check-Out and Test Procedures

Preliminary turn-on, check-out and test procedures for the CRRES Dosimeter (AFGL-701-2) and the CRRES Fluxmeter (AFGL-701-4) were forwarded to AFGL on 8 July 1985, and 15 July 1985.

3.4.8 Materials Lists

Materials lists for the CRRES Dosimeter (AFGL-701-2) and the CRRES Fluxmeter (AFGL-701-4) were forwarded to AFGL on 15 July 1985.

3.4.9 Fracture Control Analysis

A Fracture Control Analysis was made for the CRRES Dosimeter (AFGL-701-2) and for the CRRES Fluxmeter detector assembly (AFGL-701-4A) and DPU (AFGL-701-4B). The analyses were made according to guidelines suggested by BASD, and the entire analysis was submitted to AFGL in mid-January 1985. The Dosimeter analysis showed the need for flange doublers, which were subsequently included in the mounting configuration.

REFERENCES

1.1 P.R. Morel, F.A. Hanser and B. Sellers, "Fabricate, Calibrate and Test a Dosimeter for Integration into the CRRES Satellite", report AFGL-TR-84-0150, (October 1983). Scientific Report No. 1 for Contract No. F19628-82-C-0090. ADA150683.

1.2 P.R. Morel, F.A. Hanser and B. Sellers, "Fabricate, Calibrate and Test a Dosimeter for Integration into the CRRES Satellite", report AFGL-TR-85-0150, (March 1985). Scientific Report No. 2 for Contract No. F19628-82-C-0090. ADA161695.

2.1 B. Sellers, R. Kelliher, F. A. Hanser, and P. R. Morel, "Design, Fabrication, Calibration, Testing and Satellite Integration of a Space-Radiation Dosimeter," report AFGL-TR 81-0354, AD A113085, (December 1981). Final Report for Contract No. F19628-78-C-0247.

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